APPENDIX E

NOISE ANALYSIS

PREPARED BY
CHARLES M SALTER ASSOCIATES

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THE CRESCENT – HOTEL AND CONDOMINIUM BUILDINGS
NOISE IMPACT ASSESSMENT
SUNNYVALE, CALIFORNIA

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Prepared for:

DAVID J. POWERS & ASSOCIATES
Kristy Le, Assistant Project Manager
1885 The Alameda, Suite 204
San Jose, CA 95126
Phone: (408) 248-3500
Email: kle@davidjpowers.com

Prepared by:

CHARLES M. SALTER ASSOCIATES, INC.
Joshua M. Roper, Senior Consultant
Philip N. Sanders, Vice President
2880 Zanker Road, Suite 203
San Jose, CA 95134
Phone: (408) 432-7270
Email: jroper@cmsalter.com

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1. Introduction

This report summarizes an assessment of environmental noise at The Crescent site in Sunnyvale, California. The project site is the existing Four Points Sheraton Hotel, and is located east of Lawrence Expressway and south of U.S. Highway 101 (US 101), which is the primary source of noise at the site. The proposed project consists of a new hotel, at the approximate location of the main Sheraton Building, and four new seven-story condominium buildings. Figure A-1 (Appendix A) is a site plan that shows the proposed development as well as estimated future noise levels and noise measurement locations.

1.1 Summary

This project involves several potentially significant noise impacts, some of which are unavoidable, and some of which can be mitigated by integrating noise reduction measures into the building design.

- Exterior Noise Levels - Given the proximity of the project to US 101, reducing noise at the common outdoor use spaces to the noise goal in the Sunnyvale General Plan may not be feasible. The positioning of the buildings on the site does provide shielding of traffic noise for the condominium pool area, and a noise barrier wall located so as to block the line of sight from the pool area to the freeway would reduce noise levels to near the City's goal.
- Interior Noise Levels - Interior noise levels would be reduced to comply with City and State standards for interior noise levels in hotels and multi-family housing by incorporating sound-rated windows and appropriate exterior wall assemblies into the building design.
- Impact of Project Generated Noise on Adjacent Land Uses – Noise from mechanical equipment, serving the project should be addressed during design by appropriate selection, placement and screening of HVAC equipment, pool equipment, etc.

- Construction Noise – Noise from construction activities, including pile driving, excavation and building erection, will generate a temporary or periodic increase in the ambient noise level at the adjacent residential, office, and commercial uses. Mitigation includes use of mufflers on construction equipment, limitations on construction hours, per the Sunnyvale Municipal Code, and ongoing communication with neighbors.

2.0 ACOUSTICAL CRITERIA

2.1 City of Sunnyvale General Plan

The Noise Element of the City of Sunnyvale General Plan contains noise goals and policies for new developments.

- Action Statement 3.6A.1c – "Comply with the 'Noise and Land Use Compatibility Guidelines' for the compatibility of land uses with their noise environments, except where the City determines that there are prevailing circumstances of a unique or special nature." Table 1, below, summarizes the applicable parts of the land use compatibility guidelines.

Table 1 – Noise and Land Use Compatibility Guidelines for Residential Development

Noise Exposure Level Multi-Family Residential, Motels, Hotels	**Compatibility**	**Comments**
Below DNL 60 dB	Normally Acceptable	Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal, conventional construction, without any special noise insulation requirements.
DNL 60 to 75 dB	Conditionally Acceptable	Specified land use may be permitted only after detailed analysis of the noise reduction requirements and needed noise insulation features are included in the design.
>DNL 75 dB	Unacceptable	New construction or development should generally not be undertaken, because mitigation is usually not feasible to comply with noise element policies.

- Action Statement 3.6A.1f – States a goal of "... attempting to achieve an outdoor L_{dn} of no greater than 60 dBA for common recreation areas, backyards, patios, and medium and large balconies" in residential development.
- Action Statement 3.6A2a – The City of Sunnyvale has adopted the Title 24 Noise Insulation Requirements for multi-family housing and hotels.

2.2 California Noise Insulation Standards

The California Building Code (Appendix Chapter 12) contains acoustical requirements for interior sound levels in habitable rooms. In summary, the CBC requires an interior noise level no higher than DNL[1] 45 dB. Projects exposed to an exterior noise level greater than DNL 60 dB, require an acoustical analysis showing that the proposed design will limit interior levels to the prescribed allowable interior level. Additionally, if windows must be in the closed position to meet the interior standard, the design must include a ventilation or air-conditioning system to provide a habitable interior environment.

3.0 EXISTING AND FUTURE NOISE ENVIRONMENT

The primary source of noise at the site is vehicle traffic on US 101, located adjacent to the north of the site. While traffic noise from vehicles on Lakeside Drive is audible, it contributes little to the DNL.

[1] Day/Night Sound Level (DNL) — A descriptor established by the U.S. Environmental Protection Agency to describe the average day-night level with a penalty applied to noise occurring during the nighttime hours (10 pm - 7 am) to account for the increased sensitivity of people during sleeping hours.

3.1 Existing Noise Environment

To quantify the existing noise environment at the site we conducted noise measurements on 18 and 19 August 2004 and on 2 and 3 March 2005. The measurement program consisted of three long term noise monitors, each logging noise exposure levels over a 24-hour period, plus several short-term "spot" measurements at various locations and elevations. We have used these measured noise levels in combination with the project site plan dated 21 December 2004, and traffic volumes on Highway 101 as reported by CalTrans, to estimate noise exposure levels across the project site.

The DNL is 75 dB at the approximate setback of the proposed building nearest to the freeway, at approximately 18 feet above grade. Table A-1 in Appendix A summarizes measured noise data.

3.2 Future Noise Environment

Based on vehicle counts from CalTrans, the traffic volume has not increased on Highway 101 at Lawrence Expressway over the last ten years, and has decreased in some years. Some sources, however, project a 1.3% annual increase in miles traveled on highways in San Jose. Further, CalTrans reports an increase of 2.1% on highways statewide from 2003 to 2004. If traffic volume on Highway 101 were to increase at this pace – a cumulative increase of approximately 23 percent over ten years – the noise level at the site due to traffic on Highway 101 would increase by less than 1 dB. For purposes of this report we have assumed a 1 dB increase between now and 2015.

Figure A-1 shows estimated future noise levels at various locations on the site, assuming that the project is built as indicated in the site plan dated 21 December 2004, without noise barriers.

4.0 IMPACTS AND MITIGATION

4.1 Thresholds of Significance

The project would be considered to have a significant noise impact if it:

a. exposes people to noise levels in excess of the goals established in the General Plan

b. causes a substantial permanent increase in ambient noise levels in the project vicinity

c. causes as substantial temporary or periodic increase in ambient noise levels

d. exposes people residing or working in the project to excessive noise levels

For items b and c, noise level increases of fewer than 3 dB are generally considered less-than-significant. Substantial adverse community response would be expected only for increases of 5 dB or more.

4.2 General Plan Goals

4.2.1 Interior DNL

Impact: Noise exposure levels at the project site generally fall into the "conditionally acceptable" or "normally unacceptable" ranges, as defined by the California General Plan Guidelines. Calculated future noise levels at the north façade of the building closest to the freeway, are DNL 75 to 77 dB. These levels fall into the "unacceptable" range for multi-family housing. At other parts of the site, including the hotel site, noise levels are in the "conditionally acceptable range."

Mitigation: Interior noise levels can be reduced to comply with the State and City requirement of DNL 45 dB by means of sound rated windows and exterior wall assemblies. Throughout most of the site, window sound insulation ratings between STC[2] 30 and STC 36 would be required. These ratings can be achieved using well sealed dual pane windows with various glazing configurations.

Buildings with the greatest exposure to noise from Highway 101 may require windows with sound insulation ratings of approximately STC 40, depending on the size and shape of windows and rooms. Windows with sound insulation ratings of STC 40 and greater typically have either dual sashes, or large airspaces between panes.

Sound rated exterior walls incorporating either resilient channels or double stud assemblies may also be required at the facades with the greatest noise exposure. A detailed analysis should be done during design to select appropriate windows and wall assemblies.

Since windows must be closed to achieve DNL 45 dB, an alternate means of providing outside air to habitable spaces is required.

4.2.2 Outdoor Noise Levels

Impact: Exterior noise levels at the project site exceed the General Plan goal of DNL 60 dB.

Mitigation: The proposed layout of the buildings on the site, as shown in the site plan dated 21 December 2004, provides noise shielding for the pool area. With this shielding, the estimated future noise level is DNL 66 dB. A ten to fifteen-foot high sound barrier wall located so as to block the line of sight from the pool area to vehicles on the freeway would reduce the estimated outdoor noise levels to DNL 60 dB or lower for people standing or sitting in the pool area.

[2] Sound Transmission Class (STC) — A single number used to compare walls, floor/ceiling assemblies, windows and doors for their sound

Assuming that the elevation of the freeway surface and the pool deck are the same, the barrier wall could be located along the freeway, between Lakeside Drive and the project site, or on the project site. The exact height, location and extent of a sound barrier wall should be determined during the design phase, when the site plan has been finalized. Barrier walls should be constructed of concrete block, plaster, pre-cast concrete, or other solid material with a minimum surface density of 3 pounds per square foot.

4.3 Permanent Increase in Ambient Noise Levels

Impact: Mechanical Equipment associated with the project, such as cooling towers and pool equipment have the potential to exceed municipal code standards (Section 19.42.030 Sunnyvale Municipal Code).

Mitigation: Equipment should be selected and located to meet the noise standards. If necessary, additional mitigation measures, such as enclosures, acoustical louvers, or equipment noise attenuators, should be employed. A qualified professional should be involved during the design phase of the project to advise the design team regarding effective noise reduction measures.

4.4 Temporary or Periodic Increase in Ambient Noise

Impact: Construction of the project will result in elevated short-term construction noise at existing adjacent land uses, such as the Avalon Silicon Valley complex west of the site, the Residence Inn to the east, and the office buildings to the south.

The four main phases of construction are

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insulating properties with respect to speech and small household appliance noise.

- Grading, excavation and below grade work
- Structural steel, concrete and exterior finishes
- Interior framing
- Interior finishes

The noisiest of these is grading and below grade work when heavy machinery would be in use, and when pile driving, if required, would occur. Typical noise levels from these activities range from 80 to 90 dBA at 50 feet. Pile driving can generate noise levels over 100 dBA at 50 ft. Framing involves use of pneumatic tools such as nailing guns and other hand tools such as hammers and saws. The final phase is interior work, which tends to be less intrusive since the noise occurs indoors.

Table 2, below, shows typical noise levels from various construction activities.

Table 2 - Typical Construction Noise Levels

Construction Phase	Noise Level[a] (L_{eq})
Ground Clearing	84
Excavation	89
Foundation	78
Erection	85
Exterior Finishing	89
Pile Driving	90-105

Notes: [a]Estimates correspond to a distance of 50 feet from the noisiest piece of equipment associated with a given construction phase and 200 feet from other equipment associated with that phase.

Source: U.S. Environmental Protection Agency, *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*, December 1971.

Mitigation: To reduce the likelihood of residential neighbors complaining about noise, consider implementing the following:

1. Require posted signs at the construction site that include permitted construction days and hours, a day and evening contact number for the job site and a day and evening contact number for the City in the event of problems.
2. Notify neighbors of the schedule and type of equipment that would be used for each phase of construction.
3. Limit construction time to between 7:00 a.m. and 6:00 p.m. weekdays, and 8:00 a.m. to 5 p.m. Saturdays (Sunnyvale Administrative Code 16.08.110).
4. Locate noisy stationary equipment (e.g., generators and compressors) away from the most sensitive adjacent uses.
5. Require that all construction equipment be in good working order and that mufflers are inspected for proper functioning.
6. Designate a construction noise coordinator. This coordinator would be available to respond to complaints from neighbors and take appropriate measures to reduce noise.
7. If pile-driving is required, implement site-specific noise attenuation measures under the supervision of a qualified acoustical consultant. Implement as many of the following noise reduction measures as feasible:
   a. Use "quiet" pile-driving technology, such as vibration piles or pre-drilled holes, where feasible and consistent with geotechnical and structural requirements.
   b. Use noise control blankets on the building structure as it is erected to reduce noise emission from the site.

c. Evaluate the feasibility of noise control at the receivers by temporarily improving the noise reduction capability of adjacent buildings.

d. Monitor the effectiveness of noise attenuation measures by taking noise measurements.

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APPENDIX A

NOISE MEASUREMENTS

Table A-1 – Noise Measurements

Measurement Number (see Figure A-1)	Description	Date	Existing DNL
Twenty-Four Hour Continuous Measurements			
1	24-hour monitor in tree on berm approximately 35 feet south of center line of Lakeside Drive (The measurement location is closer to US 101 than any of the proposed buildings. Measured noise levels are therefore higher than estimated noise levels at proposed building setback)	18-19 August 2004	76 dB
2		2-3 March 2005	78 dB
3	24-hour monitor in tree approximately 45 feet east of centerline of Lakeside Drive	2-3 March 2005	66 dB
Fifteen-Minute Spot Measurements (DNLs determined by reference to levels recorded by 24-hour monitors)			
4	Microphone on 18 foot pole at approximate setback of proposed Building 3	19 August 2004	75 dB
5	Approximately 200 feet south of Lakeside Drive	19 August 2004	67 dB
6	Roof of existing main hotel building	2 March 2005	68 dB

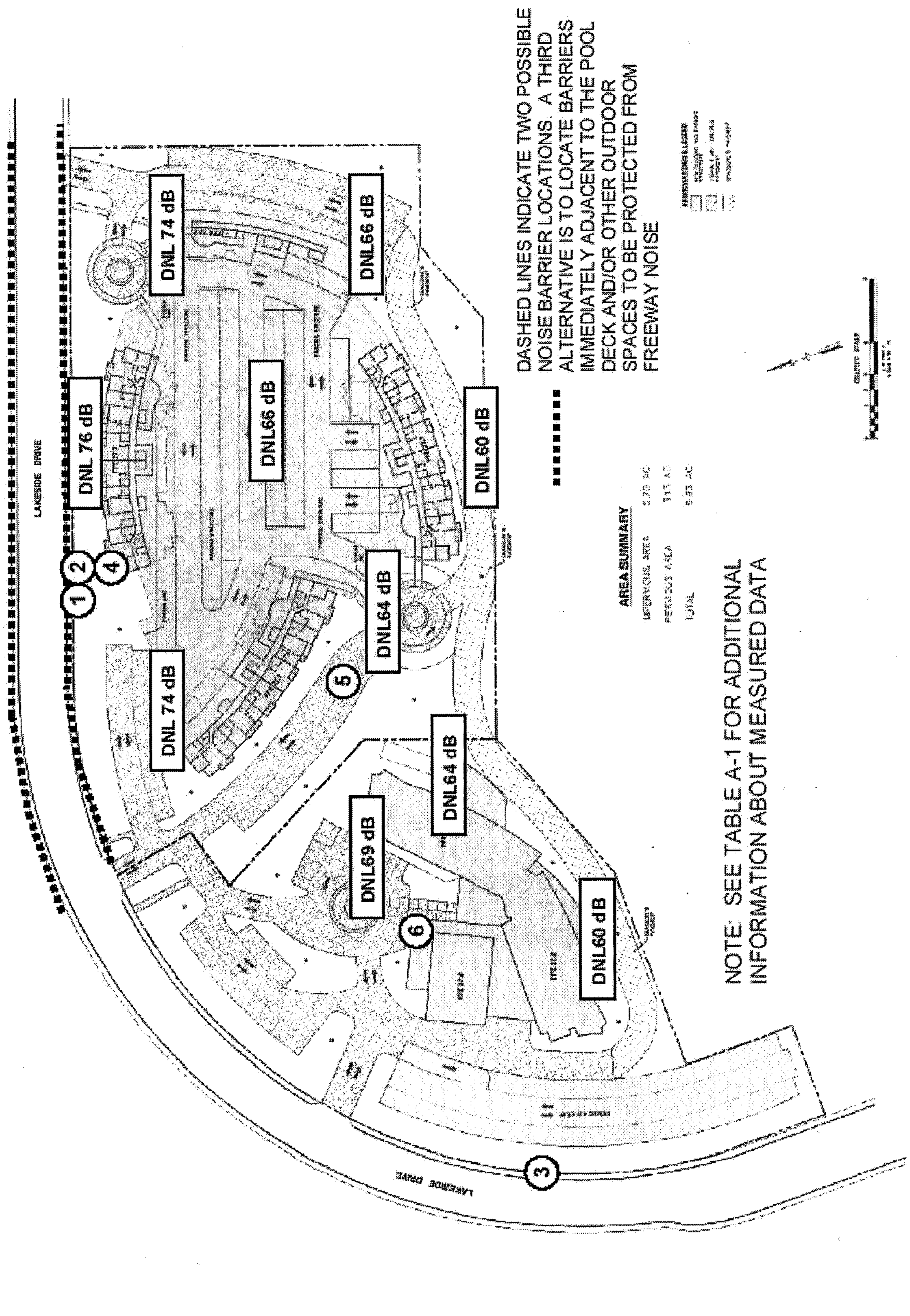

FIGURE A-1 – NOISE MEASUREMENT LOCATIONS AND ESTIMATED FUTURE NOISE LEVELS WITH PROJECT
11 MARCH 2005

APPENDIX B

FUNDAMENTAL CONCEPTS OF ENVIRONMENTAL NOISE

This appendix provides background information to aid in understanding the technical aspects of this report.

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. Sound levels are usually measured and expressed in decibels (dB), with 0 dB corresponding roughly to the threshold of hearing.

Three aspects of environmental noise are important in determining subjective response. These are:

a) The frequency spectrum of the sound;
b) The time-varying character of the sound; and
c) The intensity or level of the sound;

FREQUENCY SPECTRUM

The "frequency" of a sound refers to the number of complete pressure fluctuations per second in the sound. The unit of measurement is the cycle per second (cps) or hertz (Hz). Most of the sounds we hear in the environment do not consist of a single frequency, but of a broad band of frequencies, differing in level. The name of the frequency and level content of a sound is its sound spectrum. A sound spectrum for engineering purposes is typically described in terms of octave bands, which separate the audible frequency range (for human beings, from about 20 to 20,000 Hz) into ten segments.

Many rating methods have been devised to permit comparisons of sounds having quite different spectra. Surprisingly, the simplest method correlates with human response nearly as well as the more complex methods. This method consists of evaluating all of the frequencies of a sound in accordance with a weighting that progressively de-emphasizes the importance of frequency components below 1000 Hz and above 5000 Hz. This frequency weighting reflects the fact that human hearing is less sensitive at low frequencies and at extreme high frequencies relative to the mid-range.

The weighting system described above is called "A"-weighting, and the level so measured is called the "A-weighted sound level" or "A-weighted noise level." The unit of A-weighted sound level is sometimes abbreviated "dBA." In practice, the sound level is conveniently measured using a sound level meter that includes an electronic filter corresponding to the A-weighting characteristic. All U.S. and international standard sound level meters include such a filter.

VARIATION OF SOUND WITH TIME

Although a single sound level value may adequately describe environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise is a conglomeration of distant noise sources, which results in a relatively steady background noise having no identifiable source. These distant sources may include traffic, wind in trees, industrial activities, etc. and are relatively constant from moment to moment. As natural forces change or as human activity follows its daily cycle, the sound level may vary slowly from hour to hour. Superimposed on this slowly varying background is a succession of identifiable noisy events of brief duration. These may include nearby activities such as single vehicle passbys, aircraft flyovers, etc. which cause the environmental noise level to vary from moment to moment.

To describe the time-varying character of environmental noise, statistical noise descriptors were developed. "L_{10}" is the A-weighted sound level equaled or exceeded during 10 percent of a stated time period. The L_{10} is considered a good measure of typical maximum sound levels caused by discrete noise events. "L_{50}" is the A-weighted sound level that is equaled or exceeded 50 percent of a stated time period; it represents the median sound level. The "L_{90}" is the A-weighted sound level equaled or exceeded during 90 percent of a stated time period and is used to describe the background noise.

As it is often cumbersome to quantify the noise environment with a set of statistical descriptors, a single number called the average sound level or "L_{eq}" is now widely used. The term "L_{eq}" originated from the concept of a so-called equivalent sound level which contains the same acoustical energy as a varying sound level during the same time period. In simple but accurate technical language, the L_{eq} is the average A-weighted sound level in a stated time period. The L_{eq} is particularly useful in describing the subjective change in an environment where the source of noise remains the same but there is change in the level of activity. Widening roads and/or increasing traffic are examples of this kind of situation.

In determining the daily measure of environmental noise, it is important to account for the different response of people to daytime and nighttime noise. During the nighttime, exterior background noise levels are generally lower than in the daytime; however, most household noise also decreases at night, thus exterior noise intrusions again become noticeable. Further, most people trying to sleep at night are more sensitive to noise.

To account for human sensitivity to nighttime noise levels, a special descriptor was developed. The descriptor is called the DNL (Day/Night Average Sound Level), which represents the 24-hour average sound level with a penalty for noise occurring at night.

The DNL computation divides the 24-hour day into two periods: daytime (7:00 a.m. to 10:00 p.m.); and nighttime (10:00 p.m. to 7:00 a.m.). The nighttime sound levels are assigned a 10 dB penalty prior to averaging with daytime hourly sound levels. For highway noise environments, the average noise level during the peak hour traffic volume is approximately equal to the DNL.

SOUND LEVELS

The effects of noise on people can be listed in three general categories:

a) Subjective effects of annoyance, nuisance, dissatisfaction;
b) Interference with activities such as speech, sleep, and learning; and
c) Physiological effects such as startle, hearing loss.

The sound levels associated with environmental noise usually produce effects only in the first two categories. Unfortunately, there has never been a completely predictable measure for the subjective effects of noise nor of the corresponding reactions of annoyance and dissatisfaction. This is primarily because of the wide variation in individual thresholds of annoyance and habituation to noise over time.

Thus, an important factor in assessing a person's subjective reaction is to compare the new noise environment to the existing noise environment. In general, the more a new noise exceeds the existing, the less acceptable the new noise will be judged.

With regard to increases in noise level, knowledge of the following relationships will be helpful in understanding the quantitative sections of this report:

a) Except in carefully controlled laboratory experiments, a change of only 1 dB in sound level cannot be perceived.

b) Outside of the laboratory, a 3 dB change is considered a just-noticeable difference.

c) A change in level of at least 5 dB is required before any noticeable change in community response would be expected.

d) A 10 dB change is subjectively heard as approximately a doubling in loudness, and would almost certainly cause an adverse community response.

e) Sound levels do not combine arithmetically. Instead, they sum logarithmically, in a manner similar to the Richter scale, used for measuring the intensity of earthquakes. The following two examples may help illustrate this:

   i) If the existing noise level at a particular location is 60 dBA, and a new source of sound with a similar spectrum is introduced that also measures 60 dBA, the result is not 120 dBA, but 63 dBA.

   ii) If the existing noise level at a particular location is 60 dBA, and a new sound source with a similar spectrum is introduced that measures 50 dBA, the result is not 110 dBA, but still 60 dBA. The new source is so much quieter than the existing one that it does not contribute to the overall sound level.

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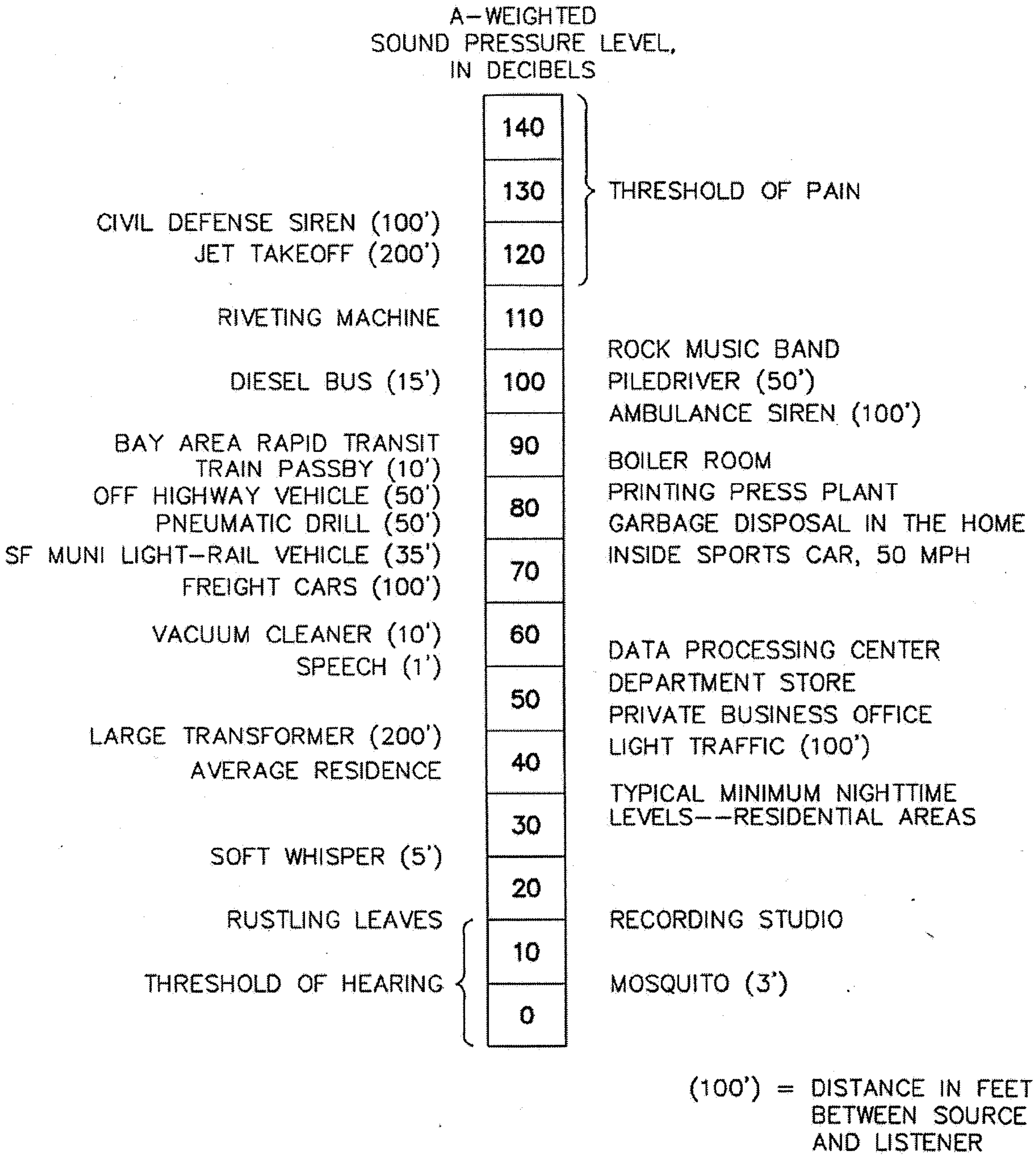

TYPICAL SOUND LEVELS MEASURED IN THE ENVIRONMENT AND INDUSTRY

FIGURE A1

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